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【文献】特開昭６１－１２９０９４（ＪＰ，Ａ）

【文献】特開昭５８－１０４６１２（ＪＰ，Ａ）

【特許請求の範囲】

【請求項１】有機性汚水を生物学的に浄化する生物処理槽と、前記処理槽内に浸漬配置された中空糸膜又はセラミック膜からなる膜モジュールと、前記膜モジュールの下方部に配置されたガスを供給するための散気装置と、前記膜の外表面から膜内部に液を透過させるための濾過手段と、前記膜の内部に膜汚染を洗浄するための洗浄剤溶液を圧入し、洗浄剤溶液を生物処理槽内に流出させる洗浄手段とからなることを特徴とする生物処理装置。

【発明の詳細な説明】〔産業上の利用分野〕本発明は有機性汚水を活性汚泥などの微生物により生物処理する装置に関するものである。

〔従来の技術〕

従来より活性汚泥処理プロセスの曝気槽内にセラミック膜又は中空糸膜を直接浸漬して曝気空気によって生起される乱流により膜の外表面に剪断流を与えつつ、ポンプにより膜透過液を吸引して処理水を得る方法が公知である。

しかし、本発明者が、この従来装置を試験したところ曝気による乱流だけでは、膜外表面の汚染を充分防ぐことができず、次第にFlux（膜透過流束m^3/m^2・日）が低下してしまうという大きな欠点があることが判明した。

従って、膜の汚染（ファウリング）を充分防止するためには定期的にNaClO等の洗浄剤により、膜表面の汚染物質を除去しなければならないが、従来装置は薬品洗浄時に膜モジュールを曝気槽から取り出し薬品で洗浄した後、再び曝気槽内に浸漬するという煩雑、面倒な作業を行わなければならなかった。

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(56) < Cited Reference (s) >

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[Reference] Japan Unexamined Patent Publication Showa 58-104612 (JP,A)

[Claim(s)]

[Claim 1] Biotreatment equipment which designates that it consists of biotreatment tank which purification is done organically contaminated water in biological , membrane module which consists ofthe hollow fiber membrane or ceramic membrane which is arranged inside aforementioned treatment tank , air disperser in order to supply gas which is arranged in downward part of aforementioned membrane module, filter means in order transmission to do liquid from outer surface of aforementioned film in membrane inside, cleaning means which pressure injection does washing agent solution in order to wash mambrane fouling inthe inside of aforementioned film, washing agent solution flows out into thebiotreatment tank, as feature.

[Description of the Invention] [Industrial Area of Application] This invention is something regarding equipment which biotreatmentis done organically contaminated water with microorganism of active sludge or the like.

(Prior Art)

Method which from conventional immersion doing ceramic membrane or hollow fiber membrane directly inside aeration tank ofthe activated sludge treatment process, while giving shear flow to outer surface of film with turbulent flow whichoccurs by aeration air, absorbing membrane-permeating liquid with pump , obtains treated water is public knowledge.

But, this inventor, when test it does this conventional equipment , with just turbulent flow due to aeration, pollution of membrane outer surface satisfactory it is not possibleto prevent, being big deficiency that flux (membrane permeation flux m^3/m^2day) decreases gradually,was ascertained.

Therefore, in order satisfactory to prevent pollution (fouling) of the film, contaminant of film surface must be removed with cleaning agent of theperiodically NaClO etc,, but. conventional equipment removes membrane module from aeration tank at time of chemical cleaningand after washing, must do troublesome , difficult work whichagain immersion is done inside aeration tank with chemical.

このような作業は実験装置ならば容易に実施はできるが、実装置規模では極めて面倒であり、殆ど実施不能と言って差し支えない。

This kind of work if it is a experimental apparatus, execution is po ssible easily,but, with actual equipment scale quite is difficult, is impractical almost.

〔発明が解決しようとする課題〕

(Problems That Invention Seeks to Solve)

本発明はこのような従来装置の欠点を解決することを課題とするものであり、膜モジュールを曝気槽内に設置したまま効果的な薬品洗浄を行えるように構成した装置を提供するものである。

This invention is something which designates that deficiency of th is kind ofconventional equipment is solved as problem while membrane module is installed inside theaeration tank in order to be able to do effective chemical cleaning, is something which offersthe equipment which is formed.

〔課題を解決するための手段〕

(means in order to solve problem)

本発明は、有機性汚水を生物学的に浄化する生物処理槽と、前記処理槽内に浸漬配置された中空糸膜又はセラミック膜から膜モジュールと、前記膜モジュールの下方部に配置されたガスを供給するための散気装置と、前記膜の外表面から膜内部に液を透過させるための濾過手段と、前記膜の内部に膜汚染を洗浄するための洗浄剤溶液を圧入し、洗浄剤溶液を生物処理槽内に流出させる洗浄手段とからなることを特徴とする生物処理装置であり、これにより上記課題を解決できる。

As for this invention, It is a biotreatment equipment which desig nates that it consists of biotreatment tank which purification isdone organically contaminated water in biological , themembrane module which consists of hollow fiber membrane or ceramic membrane which is arranged inside aforementioned treatment tank , air disperser in order to supply gas which is arranged in downward partof aforementioned membrane module, filter means inorder transmission to do liquid from outer surface of aforementioned film in membrane inside , cleaning means which pressure injection does washing agent solution in order to wash mambrane fouling inthe inside of aforementioned film, washing agent solution flows out into thebiotreatment tank, as feature, theabove-mentioned problem can be solved because of this.

本発明は、生物処理と濾過処理を平行して行う生物処理装置において該濾過処理に用いる膜モジュールを系外に取り出すことなく装置内に設置したままでより効果的に膜汚染を洗浄する装置を具備したことを特徴とするものである。

As for this invention, in biotreatment equipment which does biotr eatment and fitration inthe same time, with while it is installed inside equipment without removing membrane moduleusing for said fitration to outside the system, from it is something whichdesignates that equipment which effectively washes mambrane fouling ispossessed as feature.

即ち、本発明は生物処理および活性汚泥の濾過処理の進行に伴って膜外表面、即ち、処理槽内液と接触する側の膜表面（従って、膜内部とは該処理槽内液に接触しない側を指す。）に付着した汚染物質により膜透過流束が低下する。この時、膜の洗浄が必要になるが、本発明では膜モジュールをそのままの状態で、濾過用ポンプを止め洗浄剤溶液を膜内部に洗浄用ポンプにより圧入し、膜内部から外部に洗浄液を移動させるとともに散気装置からエアレーションして処理槽内液に乱流を与えることにより膜に付着したSS、スライムなどの汚染物質を剥離、除去するものである。

Namely, as for this invention, attendant upon advance of fitratio n ofthe biotreatment and active sludge, membrane permeation flux decreases membrane outer surface , namely, with contaminant which depositsin membrane surface (Therefore, membrane inside it points to side which does not contact thesaid treatment tank internal liquid.) side which contacts with treatment tank internal liquid. This time, washing film becomes necessary, but, with this invention membrane module with that way state, filtration pump is stopped and cleaning agent solution pressure injection is done in membrane inside with washing pump , cleaning liquid is moved to outside from membrane inside, aeration doing from air disperser, it is something which removes thecontaminant of SS, slime or the like which deposits in film by giving turbulent flow tothe treatment tank internal liquid.

この場合、膜モジュールは外圧型であるから濾過手段は、液が膜外部から膜内部に移動するように膜と処理槽内液間に圧力差が発生するように設けられ、その配置は任意である。例えば、膜内部をポンプでの吸引および／または水位

In this case, because membrane module is external pressure type, i n order for liquidfrom film outside to move to membrane inside, way pressure difference occurs between the film and treatment tank internal liquid, providing filter means. Arrangement is

差を利用して処理水を流出することが挙げられる。

optional. for example, itcan list treated water that it flows out, membrane inside with pump making use of absorption and water level difference .

また、膜洗浄時の洗浄手段は、上記濾過処理と逆の方向に液が移動するように洗浄剤溶液をポンプで圧入するように構成するのがよい。

In addition, as for cleaning means at time of membrane cleaning, way liquidmoves to direction of opposite to above-mentioned fitration, in orderthe pressure injection to do washing agent solution with pump, it is good to form.

また、本発明は膜洗浄終了時、膜モジュール内に洗浄溶液が残留する場合、ポンプにてこれを吸引して洗浄剤溶液貯槽に回収するようにすることができる。

In addition, this invention at time of membrane cleaning end, whe n cleaning solutionremains inside membrane module, absorbing this with pump , in order torecover in cleaning agent solution storage tank, is possible.

本発明において、洗浄剤溶液の圧入は、一般的に１～5kgf／cm^2、好ましくは、１～2kgf／cm^2の圧力で、10～30分間の範囲から選択される。この場合、上記値は、汚染物質の種類（即ち、原水種類）、膜孔径等により適宜調整される。

In this invention, pressure insertion of cleaning agent solution, wi th pressure of 1 to 5 kgf/cm^2 , the preferably, and 1 to 2 kgf/cm^2, is selected generally from range of the10 to 3 0-minute. In this case, above-mentioned value is adjusted appropriately thekinds of contaminant (Namely, raw water kinds), by film pore diameter etc.

本発明に使用される洗浄剤溶液は、公知の薬剤を所定濃度に調整した水溶液を用いるが、膜洗浄を洗浄剤溶液と単なる水との洗浄とを併用して使用してもよい。

Cleaning agent solution which is used for this invention uses aqueo us solution which adjustedthe chemical of public knowledge specified concentration, but jointly using with cleaning agent solution and water washing, it is possible to use membrane cleaning.

洗浄剤として例えば、NaClOを用いた場合、その溶液濃度は、0.03～１重量%、好ましくは、0.03～0.05重量%である。また、処理槽容量が10m^3、膜モジュール表面積が200m^2の洗浄の時、該洗浄剤溶液は100～200使用でき、膜を充分に洗浄できる。これは、該洗浄剤が微生物に悪影響を与える量は200g／m^3以上であるので、本発明は膜を充分に洗浄できると共に微生物に悪影響を与えない非常に有効な洗浄方法であることがわかる。

When for example NaClO are used as cleaning agent, solution con centration, is the0.03 to 1 wt% , preferably, and 0.03 to 0.05 wt%. In addition, when treatment tank capacity 10 m^3 and membrane module surface area are washing the200 m^2, 100 to 200 be able to use said cleaning agent solution, film can be washed inthe satisfactory. Because , as for quantity where said cleaning agent gives theadverse effect to microorganism it is above 200 g/m^3, this invention can wash film in satisfactory. It understands that it is a extremely effective washing method which does not give adverse effect to the microorganism.

本発明の処理槽は、洗浄時に空気を使用するならば、一種の好気性生物処理槽とすると好都合であるが、特にその微生物処理における好気性、嫌気性は限定されない。

Treatment tank of this invention, if when washing air is is used, w hen itmakes aerobic biotreatment tank of one kind, is conducive, but aerobic and the anaerobic in especially biotreatment are not limited.

本発明において膜洗浄を通して嫌気性を確保するためには散気装置に窒素等のガスを用いればよい。また、該散気装置の槽内の具体的配置は特に限定されず、上記機能が発揮できるように構成されればよいが、少なくとも、膜モジュール下部からエアレーションできるように配置されることが好ましい。

In this invention in order to guarantee anaerobic through membran e cleaning, thegas of nitrogen etc should have been used for air disperser. In addition, concrete arrangement of inside tank of said air disperserespecially is not limited and in order to be able to showabove-mentioned function, if should have been constituted. At least, in order that from membrane module bottom aeration it to be possible, itis desirable to be arranged.

従って、本発明においては処理槽に導入されて、生物処理され得る有機性汚水の水質の種類、程度は特に限定されない。この場合、該有機性汚水は、生物処理されていないものでも生物処理された活性汚泥を含むものでもよい。そのため本発明は生物処理槽の前段および／または後段に他の

Therefore, in this invention, being introduced by treatment tank, kind , extent ofthe water quality of organically contaminated water which biotreatment can be done especially is notlimited. In this case, said organically contaminated water, even when being something which biotreatment isnot done may be something

任意の生物処理槽または生物処理槽以外の公知の処理槽を包含することができる。そしてこれら他の処理槽には該膜モジュールで濾過処理された処理水および／または活性汚泥スラリーを導入することができる。これら他の処理槽が生物処理槽の場合、生物処理条件は好気的条件でも嫌気的条件でもよい。

which includes active sludge which biotreatment isdone. Because of that as for this invention, in prestage and/or poststage of biotreatment tank, ther optional biotreatment tank or treatment tank of public knowledge other than biotreatment tank can be included. And treated water and/or active sludge slurry which fitration is done to these other treatment tank with thesaid membrane module can be introduced. When these other treatment tank are biotreatment tank, biotreatment condition with aerobic condition and isgood with anaerobic condition.

また、本発明の生物処理槽は、膜モジュールが存在する所と他の空間とを隔壁により仕切り、膜モジュールが存在する空間とそれが存在しない空間とに分け各空間を同一または異なる微生物成育条件の生物処理槽として機能させることができる。同一成育条件で分けても膜モジュールが存在する方は、濾過機能が生物処理に比して優先され、それが存在しない方は生物処理専用となる。また、異なる成育条件の場合は、例えば、膜モジュールが存在する空間をアンモニア性窒素成分を硝化する好気的な硝化部とし、それが存在しない空間を嫌気的な脱窒素部として、これに該硝化部で硝化されたNO$_x$ - N液を流入させ脱窒素することができる。

In addition, as for biotreatment tank of this invention, it divides with point where membrane module exists and otherspace with septa , divide with into space where membrane module exists and spacewhere that does not exist. It can function each space as biotreatment tank of microorganism growth condition which same or differs. Dividing with same growth condition, one where membrane module exists isdone, filtration function comparing to biotreatment, priority. One where that does not exist becomes biotreatment exclusive use. In addition, in case of growth condition which differs, space where membrane module exist is designated as aerobic nitrification part which ammonia nitrogen componentthe nitrification is done. With space where that does not exist as anaerobic denitrification part. In this, NOx-N liquid which nitrification is done flowing, denitrification ispossible with said nitrification part.

このように生物処理槽を上記のように隔壁で仕切ることにより各空間が機能分離され、より効率的、省スペース的な生物処理が可能である。この場合、各空間間は該隔壁および／または管路を介して活性汚泥スラリーおよび／または膜透過水が循環するように構成することができる。

This way, each space functional isolation is done by as description above dividingthe biotreatment tank with septa. More efficient, space-saving biotreatment is possible. In this case, through said septa and/or pipe, in order for active sludge slurry and/or membrane-permeated water to circulate,it can constitute between each space.

本発明は、膜モジュールの洗浄で剥離した膜汚染物質を系外に排出する排出装置、生物処理槽で利用された不要な活性汚泥を排出する排出装置を具備できる。

As for this invention, waste discharge equipment which discharges membrane foulant which peels offwith washing membrane module in outside the system, waste discharge equipment which discharges unnecessary active sludge which is utilized with biotreatment tankcan be possessed.

〔実施例〕

(Working Example)

以下、本発明の具体的実施例を第１図を参照しながら説明すると共に本発明の構成と作用を中空糸膜を使用した例で説明する。

Below, concrete Working Example of this invention while referri ng to Drawing 1,as you explain, you explain constitution and action of this inventionwith example which uses hollow fiber membrane.

１は、下水等の有機性汚水の流入部、２は活性汚泥処理槽、３は空気散気部材である。

As for 1, flow inlet of organically contaminated water of sewer et c. As for 2 activated sludge treatment tank . 3 is air-dispersing member.

中空糸膜モジュール４が空気散気部材の上部に懸下、浸漬されており、散気空気によって引き起こされる乱流が中空糸膜の表面におよぶように配置されている。中空糸膜モジュール４は、極めて多数の中空糸が束状になっており、中空糸の外表面で活性汚泥SSが膜分離され、１本１本の中空

Hollow fiber membrane module 4 is hang upper part of air-dispersi ng member, immersion is done. In order for turbulent flow which is caused by dispersed air to reach to thesurface of hollow fiber membrane, it is arranged. As for hollow fiber membrane module 4, quite multiple hollow fiber has become bundle. active sludge SS

糸の内部に透過した液が濾液集水部５に集まり、吸引ポンプ６により吸引されSSが完全に除去された清澄処理水７が得られる。

membrane separation is done with outer surface of hollow fiber. liquid which transmission is done inside of hollow fiber of one-by-one in filtrate water collector 5 gathering, it is absorbed by suction pump 6 , clarified water 7 where SS is removedcompletely is acquired.

中空糸膜の表面には曝気空気による激しい乱流が与えられるため、活性汚泥が付着する度合いが少なく、安定した膜透過流束が長時間得られる。しかしながら、長時間経過すると何らかの膜汚染物質（活性汚泥が分泌するタンパク等の生体高分子を主とするものと推定される。）が主に中空糸膜の表面に吸着し、膜透過流束が著しく低下してくる。

In surface of hollow fiber membrane because it can give turbulent fl ow due to theaeration air, extent where active sludge deposits is little. membrane permeation flux which it stabilizes is acquired long time . But, when long time it elapses, a some membrane foulant (active sludge is presumed those which make biopolymer of protein etcwhich secretion is done main.) adsorbs into surfaceof hollow fiber membrane mainly, membrane permeation flux decreases considerably.

そのため、従来は中空糸膜モジュール全体を活性汚泥処理槽２から取り出し、NaOH、HCl、NaClO等の膜洗浄剤の溶液に浸漬し、膜汚染物質を化学的に除去した後、再び該処理槽内に浸漬し、運転を再開する必要があった。しかし、このような作業は実験装置規模では実施可能であっても、実装置では極めて面倒であり、実施困難である。

Because of that, conventional , removes hollow fiber membrane module entirety from activated sludge treatment tank 2. immersion it does in solution of membrane cleaning agent of NaOH, HCland NaClO etc. membrane foulant after chemically removing, immersion is done again inside thesaid treatment tank. It was necessary to reopen driving. But, this kind of work with laboratory scale being a practical, with actual equipmentquite is difficult, is impractical.

本発明は次のような新規構成により、このような欠点を完全に解決できる。

This invention can solve this kind of deficiency completely with n ext kindof novel constitution.

即ち、薬品洗浄を行おうとする場合、中空糸膜を処理槽に浸漬したまま弁８を閉じ、ポンプ６を停止し、弁９を開け、膜洗浄剤溶液貯槽10内液をポンプ11によって中空糸膜モジュール内に圧入する。膜洗浄剤溶液は濾液集水部５を経由して１本１本の中空糸の内部に流入し、中空糸膜の内部から外表面にむけて透過してゆく。この時、中空糸膜の外表面に吸着している汚染物質が洗浄剤と接触し、化学変化を起こし、剥離、除去されやすくなることが確かめられた。

Namely, when it tries to do chemical cleaning, hollow fiber membrane while immersion it isdone, valve 8 is closed in treatment tank. pump 6 is stopped, valve 9 is opened, membrane cleaning agent solution storage tank 10 internal liquid pressure injection is doneinside hollow fiber membrane module with pump 11. membrane cleaning agent solution via filtrate water collector 5, flows into inside of hollow fiber of the one-by-one. transmission it does from inside of hollow fiber membrane destined for outer surface. This time, contaminant which has adsorbed into outer surface of hollow fiber membranecontacts with cleaning agent. chemical conversion happened, to be exfoliated and removed could verify that itbecomes easy.

膜洗浄剤溶液の圧入を所要時間（通常10～30min程度でよい。）続けながら空気散気部材３によりエアレーションを行うと、中空糸膜の外表面に強固に吸着していた膜汚染原因物質（膜透過流束の低下をもたらす物質）が除去され、膜透過流束が回復する。

While time required (It is possible to be a 10 to 30 min extent usu ally.) continuing pressure injection of membrane cleaning agent solution, when it does theaeration with air-dispersing member 3 , mambrane fouling cause substance (Decrease of membrane permeation flux is brought substance) which has adsorbed into firm in outer surface of hollow fiber membrane isremoved, membrane permeation flux recovers.

中空糸膜の外表面から活性汚泥処理槽内に滲出する膜洗浄剤は活性汚泥の活性になんら悪影響を与えないことも確かめられた。

Membrane cleaning agent which exudation is done from outer surfa ce of hollow fiber membrane could verify also that adverse effect is not given to activity of active sludgeinside activated sludge treatment tank.

しかして、弁９を閉じ、圧力ポンプ11を停止した後、弁８を開け、吸引ポンプ６を駆動し、弁12を閉じ、弁13を開放し、中空糸膜内に残留している洗浄剤を膜洗浄剤溶液貯槽

And, valve 9 is closed, pressure pump 11 after stop, valve 8 is op ened,the suction pump 6 is driven. valve 12 is closed, valve 13 is opened. cleaning agent which has remained inside hollow fiber

10に戻した後、弁13を閉じ、弁12を開け処理水７を得る。

以上のような作用により、中空糸膜を該処理槽２に浸漬したままで極めて効果的に膜の外表面の汚染物質を洗浄することができる。尚、セラミック膜でも全く同様に行うことが可能である。

また、活性汚泥処理槽２に隔壁14を設けて、弁15を閉として、隔壁に対して左側の中空糸膜の存在しない空間を脱窒素部、同右側の空間を硝化部となるように構成することができる。この場合、隔壁は脱窒素部と硝化部が一部連通するように設けても完全に仕切ってもよく、活性汚泥が該脱窒素部と硝化部間を自然に移動できるようにしても、脱窒素部と硝化部間に適宜、管路、弁、ポンプ等を設定することにより活性汚泥および／または硝化部で中空糸膜処理された硝化液の移動を制御するようにしてもよい。

〔発明の効果〕

膜モジュールを生物処理槽から取り出すことなく、薬品洗浄が可能であり、作業性が大幅に向上する。

本発明の薬品洗浄とエアレーションによる乱流を膜表面に与える方法の併用により、膜透過流束を半永久的に安定して高い値に維持できる。

生物処理槽を仕切るここことにより、硝化脱窒素を省スペースで行うことができる。

【図面の簡単な説明】第１図は、本発明装置の具体的実施例の一つを説明するための説明図である。

符号の説明

1:流入部、2:活性汚泥処理槽

3:空気散気部材、4:中空糸膜モジュール

5:濾液集水部、6:吸引ポンプ

7:清澄処理水、8:弁

9:弁、10:膜洗浄剤溶液貯槽

11:ポンプ、12:弁

membrane is reset to membrane cleaning agent solution storage tank 10,the valve 13 is closed, valve 12 is opened and treated water 7 is obtained.

Like above with action, with while immersion it is done hollow fiber membrane ,quite contaminant of outer surface of film can be washed effectively inthe said treatment tank 2. Furthermore, it is possible to do completely in same way even withthe ceramic membrane.

In addition, providing septa 14 in activated sludge treatment tank 2, with valve 15 as closing, space where hollow fiber membrane of left side does not exist vis-a-visthe septa can be formed in order to become denitrification part, space of same right side can be formed in order to become thenitrification part. In this case, in order denitrification part and nitrification part one part to connect,even when providing it is possible to divide septa completely. It is possible active sludge said denitrification part and to be able to move between thenitrification part to natural. It is possible to control movement of nitrification liquid which is treatedthe hollow fiber membrane with active sludge and/or nitrification part, by setting pipe , valve and pump etc as needed between denitrification part and nitrification part.

(Advantages of invention)

(i) . chemical cleaning is possible without removing membrane module from biotreatment tank, the workability improves greatly.

(ii) . Stabilizing membrane permeation flux in semipermanent with combined use of methodwhich gives turbulent flow due to chemical cleaning and aeration of this invention to film surface, itcan maintain in high value.

(iii) . It is possible to do nitrification denitrification with space-saving, with with here wherethe biotreatment tank is divided.

[Brief Explanation of the Drawing(s)] Drawing 1 is explanatory diagram in order to explain one of concreteWorking Example of this invention equipment.

Explanation of code

1: Flow inlet and 2: Activated sludge treatment tank

3: Air-dispersing member and 4: Hollow fiber membrane module

5: Filtrate water collector and 6: Suction pump

7: Clarified water and 8: Valve

9: Valve and 10: Membrane cleaning agent solution storage tank

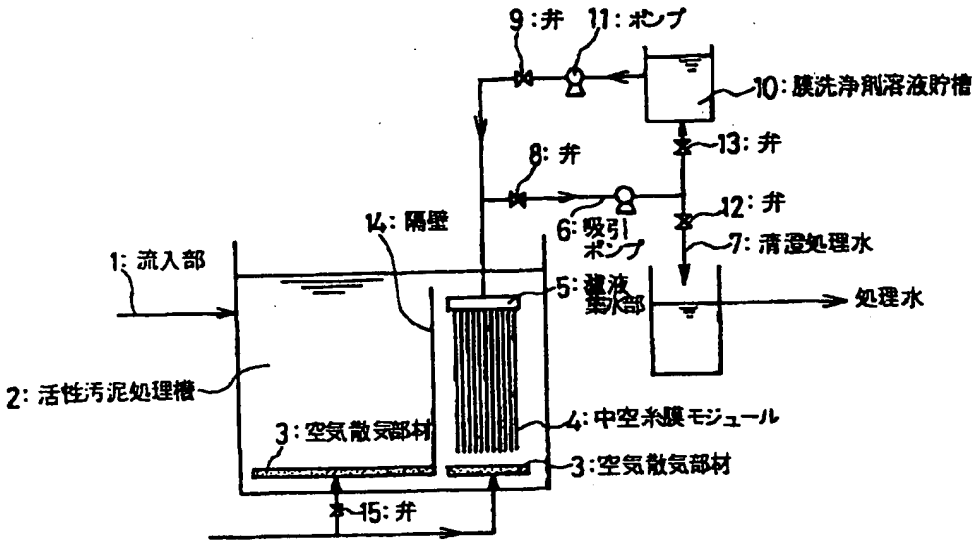
11: Pump and 12: Valve

13:弁、14:隔壁

15:弁

13: Valve and 14: Septa

15: Valve



【第1図】

< Drawing 1 >

Japanese Patent Application Laid-Open (JP-A) No.4-131,182

Laying-open Date: May 1, 1992

Title: EQUIPMENT FOR BIOLOGICALLY TREATING ORGANIC FOUL WATER

Request for Examination: Not requested

Application Number: 2-248,836

Application Date: Sept. 20, 1990

Inventor: Katsuyuki Kataoka

Applicants: Ebara Infilco Co., Ltd., and Ebara General Research Laboratory Co., Ltd.

Specification

1. Title of the invention

An equipment for biologically treating organic foul water

2. What is claimed is:

A biologically treating equipment comprising a biologically treating tank which biologically purifies organic foul water, a membrane module which is made of a hollow fiber or ceramic membrane and which is placed by immersion in the treating tank, a filtering means which causes a liquid to pass from the outer surface side to the inner side of the membrane, and a cleaning means which introduces by pressure a cleaning agent solution, intended for the cleaning of the fouled membrane, into the inner side of the membrane.

3. Detailed Description of the Invention

[Field of the Invention]

The present invention relates to an equipment which biologically treats organic foul water by means of a microorganism such as activated sludge.

[Prior Art]

Heretofore, publicly known is a method whereby a ceramic membrane or a hollow fiber membrane is immersed directly in an aeration tank of an activated sludge process to obtain treated water as a permeated liquid under suction by a pump while an aeration-induced turbulent flow provides a shearing flow onto the outer surface of the membrane.

After the operation for test of a conventional equipment, the present inventor has found that the fouling on the outer surface of the membrane cannot be sufficiently prevented by the aeration-induced turbulent flow, thereby resulting in a serious drawback that the flux, which is expressed in $m^3/m^2 \cdot day$, drops.

Therefore, in order to keep the membrane satisfactorily free of fouling, the fouling substances on the outer surface of the membrane need to be removed periodically by use of a cleaning agent such as NaClO. The above-mentioned cleaning of the conventional equipment has required a complicated and troublesome operation which includes taking the membrane module out of the aeration tank, cleaning the membrane module with a

chemical and then immersing the membrane module again in the aeration tank.

Such an operation, though easily done in an experimental scale equipment, is extremely troublesome, and can be said impossible, in an industrial scale equipment.

[Problems to be solved by the Invention]

The object of the present invention is to eliminate the above-described drawback of the conventional equipment. And, the present invention provides an equipment which allows for an effective chemical-cleaning of the membrane module while it is kept in the aeration tank at the time of cleaning operation.

[Means to solve the Problem]

According to the present invention, there is provided a biologically treating equipment comprising a biologically treating tank which biologically purifies organic foul water, a membrane module which is made of a hollow fiber or ceramic membrane and which is placed by immersion in the treating tank, a filtering means which causes a liquid to pass from the outer surface side to the inner side of the membrane, and a cleaning means which introduces by pressure a cleaning agent solution, intended for the cleaning of the fouled membranes, into the inner side of the membrane. This equipment eliminates the aforementioned problem.

The present invention is a biologically treating equipment for performing at the same time a biological treatment and a filtering treatment by use of a membrane and is characterized in that the equipment has a device for more effectively cleaning the membrane module which does not need to be taken out of the system for the cleaning operation.

As the biological treatment and the activated sludge filtering treatment proceed, the flux through the membrane decreases due to the fouling substances that adhere to the outer surface of the membrane, i.e., membrane surface which comes into contact with the liquid in the treating tank (accordingly, the inner side of membrane means the side which does not come into contact with the liquid in the treating tank). According to the present invention, while the membrane module continues to remain in the same state, the adherent fouling substances, such as SS and slime, on the membrane are removed by the procedure consisting of stopping the pump for filtration, forcibly introducing a cleaning solution into the inner side of the membrane by means of a pump to cause the cleaning agent solution move from the inner side to the outer side of the membrane, and, if necessary, imparting a turbulent flow to the liquid in the treating tank as a result of aeration by means of a diffuser.

In this case, since the membrane module functions

depend on an external pressure, the filtering means is disposed in any appropriate arrangement so that a pressure differential is generated between the membrane and the liquid in the treating tank to enable the liquid to move from the outer side to the inner side of the membrane. For example, the treated water may flow out by means of a pump-induced suction and/or water level differential.

The cleaning means is arranged to forcibly introduce the cleaning solution by a pump so that the liquid moves in the direction reversal to the liquid transfer encountered in the above-mentioned filtering treatment.

Besides, if the cleaning agent solution remains within the membrane module when the membrane cleaning operation finishes, the remaining solution may be recovered by means of the suction by a pump and will be introduced into the storage tank of the cleaning agent solution.

In the present invention, the pressure, which is to be applied to the cleaning agent solution for its forcible introduction, is in the range of 1 - 5kgf/cm^2, preferably 1 - 2kgf/cm^2, and the duration ranges from 10 to 30 minutes. However, the above-mentioned figures are appropriately adjusted depending on such factors as the types of the fouling substances (i.e., the types of raw water) and the pore diameter of the membrane.

The cleaning agent solutions to be used in the present invention are aqueous solutions prepared by diluting publicly known chemicals to predetermined concentrations. However, the cleaning operation of the membrane may consist of a combination of cleaning with a cleaning agent solution and cleaning with simple water.

For example, in the case where NaClO is used as a cleaning agent, the concentration of the solution is in the range of 0.03 - 1 percent by weight and preferably in the range of 0.03 - 0.05 percent by weight. For example, in the case where the treating tank has a capacity of 10m3 and the surface area of the membrane module is 200m^2, the usable quantity of the above-mentioned cleaning agent solution will be 100 - 200L for a satisfactory cleaning level of the membrane. Since the minimum amount deleterious to the microorganism of the above-mentioned cleaning agent is 200g/m^3, it is apparent that the cleaning method of the present invention provides a sufficient cleaning effect without adversely affecting the microorganism and can be a very efficient method.

If air is utilized in the cleaning operation, the use of a treating tank based on an aerobic microorganism is advantageous in the present invention. However, the treating tank of the present invention is not limited to aerobic or anaerobic nature in the microorganism-induced treatment.

In the present invention, in order to secure the anaerobic environment through the cleaning of the membrane, a gas, such as nitrogen, may be used in the diffuser. The location of the diffuser in the tank is not particularly limited and the diffuser can be disposed in a location which enables the diffuser to perform the above-mentioned function. However, the diffuser is preferably disposed in a location which at least enables the diffuser to cause the aeration from beneath the membrane module.

Therefore, there are no particular limitations in terms of the types or levels of fouling of organic foul water that is to be introduced in the treating tank for biological treatment. In this case, the organic foul water may be biologically untreated water or biologically treated water that contains activated sludge. And, the present invention may additionally install, prior to and/or posterior to the biologically treating tank, any other biologically treating tank or non-biologically treating, publicly known tank. Any of the above-mentioned additional treating tanks may contain treated water filtered through the membrane module and/or activated sludge slurry. In the case where an additional treating tank is a biologically treating tank, the biologically treating condition may be either aerobic or anaerobic.

Besides, in the biologically treating tank of the present invention, the zone where the membrane module is present can be separated from other zone where the membrane module is absent by means of a partition wall to create discrete zones so that each of the zones functions as a biologically treating tank under the same or different growing condition of microorganism. Even if the growing condition is the same, the filtering function is preferentially performed relative to the biological treatment in the zone where the membrane module is present, whereas the zone where the membrane module is absent is exclusively for biological treatment. If the growing condition differs, for example, the zone where the membrane module is present is utilized as a compartment for an aerobic nitrification to nitrify the ammoniacal nitrogen components, whereas the zone where the membrane module is absent is utilized as an anaerobic denitrification compartment to which the NO_x-N liquid can be fed from the above-mentioned nitrification compartment.

As explained above, dividing the biologically treating tank into zones by means of partition wall makes the functions of the zones discrete and realizes a more efficient and more space-saving biological treatment. In this case, a construction is possible which allows the circulation of the activate sludge and/or membrane-permeated water to take place in each of the zones

through the partition wall and/or pipes.

The equipment of the present invention may have a discharge device for taking out of the system the membrane fouling substances that will be removed as a result of the cleaning of the membrane module and a discharge device for discharging the unnecessary residual activated sludge from the biologically treating tank.

[Example]

Below, an embodiment of the present invention is explained with reference to Fig. 1, and the constitution and working of the present invention are described in an example utilizing a hollow fiber membrane.

1 is an inlet for organic foul water such as sewage water; 2 is an activated sludge process tank; and 3 is an air diffusing member.

A hollow fiber membrane module 4 is immersed in the liquid in a suspended state above the air diffusing member so that the turbulent flow which is induced by the diffused air reaches the surface of the hollow fiber membrane. The hollow fiber membrane module 4 comprises a bundle of a very large number of hollow fibers. At the outer surface of the hollow fibers, the membrane separates the activated sludge SS from the liquid so that the liquid enters inside of each of the hollow fibers by way of permeation to be collected at a filtrate collecting part 5. Then, clear treated water 7 is

obtained which is perfectly free of SS as a result of suction by a suction pump 6.

The surface of the hollow fiber membrane, which is given a vigorous turbulent flow, is relatively well protected against the fouling by the activated sludge and therefore a stable flow of flux through the membrane can be obtained for a prolonged period of time. However, with lapse of time, a sort of membrane fouling substance (presumably a substance comprised primarily of a biopolymer secreted from the activated sludge) starts adhering mainly to the surface of the hollow fiber membrane to thereby markedly drop the flux.

Therefore, in order to prevent the above-described problem, it has been hitherto necessary to take out of the activated sludge process tank 2 a whole set of the hollow fiber membrane module, which is then immersed in a solution of a cleaning agent, such as NaOH, HCl or NaClO, for chemically removing the membrane fouling substances and thereafter is immersed again in the treating tank so that the treating operation is started again. The above-mentioned operation for cleaning, though easily done in an experimental scale equipment, is extremely troublesome, and is impossible in an industrial scale equipment.

Because of the novel constitution, the present invention can completely eliminate the above-mentioned drawback.

When performing a chemical cleaning operation, the procedure consists of closing a valve 8 while the hollow fiber membrane is immersed in the treating tank, stopping a pump 6, opening a valve 9 and forcibly introducing the liquid from a cleaning agent solution storage tank 10 into the hollow fiber membrane module by means of a pump 11. Then, the cleaning agent solution enters inside of each of the hollow fibers via the filtrate collecting part 5 to move from the inner side to the outer side of the hollow fiber membrane by way of permeation. In this case, it has been confirmed that the fouling substances, which have been adsorbed on the outer surface of the hollow fibers, contact with the cleaning agent to undergo a chemical change and become easily removable.

The aeration by means of the air diffusing element 3, while continuing the forcible introduction of the cleaning agent solution for a predetermined period of time (normally 10 - 30 minutes), removes the membrane fouling substances (substances causing the reduction of the flux through the membrane), which have strongly adhered to the outer surface of the hollow fiber membrane, and, as a result, the flux rate through the membrane recovers.

Besides, it has been confirmed that the membrane cleaning agent, which permeates through the outer surface of the hollow fiber membrane into the activated sludge

process tank, exerts no deleterious influence on the activity of the activated sludge.

Then, the treated water 7 is obtained after sequential steps of closing the valve 9, stopping the pressurizing pump 11, opening the valve 8, driving the suction pump 6, closing the valve 12, opening the valve 13, returning the cleaning agent that remains within the hollow fiber membrane to the cleaning agent solution storage tank 10, closing the valve 13 and opening the valve 12.

Based on the above-described working, according to the present invention, it is possible to clean extremely effectively the outer surface of the hollow fiber membrane to remove the fouling substances, while the membrane is immersed in the treating tank 2. The same procedure applies to a ceramic membrane, too.

Besides, a partition wall 14 is provided in the activated sludge process tank 2 and the valve 15 is closed to thereby present a construction such that the zone, which is left to the partition wall and in which the membrane module is absent, is utilized as a denitrification compartment, and the zone, which is right to the partition wall, is utilized as a compartment for nitrification. In this case, the partition wall may allow a partial communication between the denitrification compartment and the nitrification compartment, or may

completely separate the two compartments. Alternatively, a construction is also possible which allows the free movement of the activated sludge between the denitrification compartment and the nitrification compartment or which regulates the movement of the activated sludge and/or of the nitrified liquid treated in the nitrification compartment with the hollow fiber membrane by providing appropriately such means as pipes, valves and pumps between the denitrification compartment and the nitrification compartment.

[Advantageous effects of the invention]

(1) Workability is remarkably enhanced because the chemical cleaning of the membrane module is possible without taking it out of the biologically treating tank.

(2) The flux through the membrane can be maintained at a high value in a stable and almost permanent manner as a result of the combination of the chemical cleaning and turbulent flow given to the surface of the membrane by aeration in accordance with the present invention.

(3) The nitrification and denitrification can be performed in a space-saving manner by partitioning the biologically treating tank into zones.

4. Brief description of the drawing

Fig. 1 illustrates an embodiment of the equipment according to the present invention.